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Smith

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(54) **OBTAINING VIEWER DEMOGRAPHICS THROUGH ADVERTISEMENT SELECTIONS**

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H04N 21/45	(2011.01)
H04N 21/482	(2011.01)
H04N 21/8545	(2011.01)
H04N 21/442	(2011.01)
H04N 21/25	(2011.01)
H04N 21/4725	(2011.01)
H04N 21/44	(2011.01)

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CPC ***H04N 21/812*** (2013.01); ***H04N 21/251*** (2013.01); ***H04N 21/25883*** (2013.01); ***H04N 21/44222*** (2013.01); ***H04N 21/4532*** (2013.01); ***H04N 21/4725*** (2013.01); ***H04N 21/482*** (2013.01); ***H04N 21/8545*** (2013.01); *H04N 21/44008* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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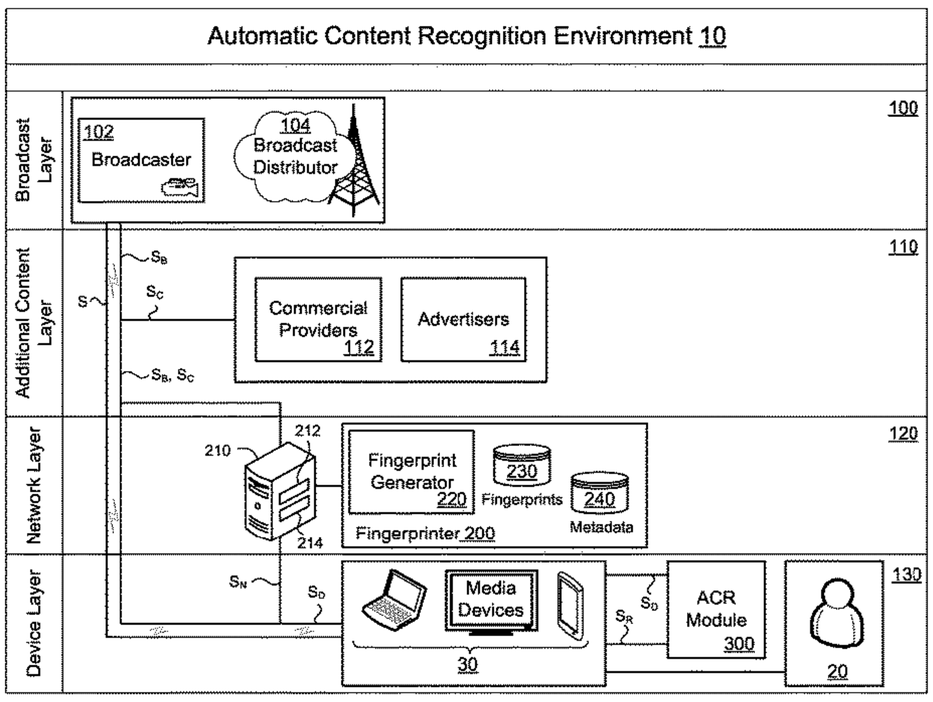
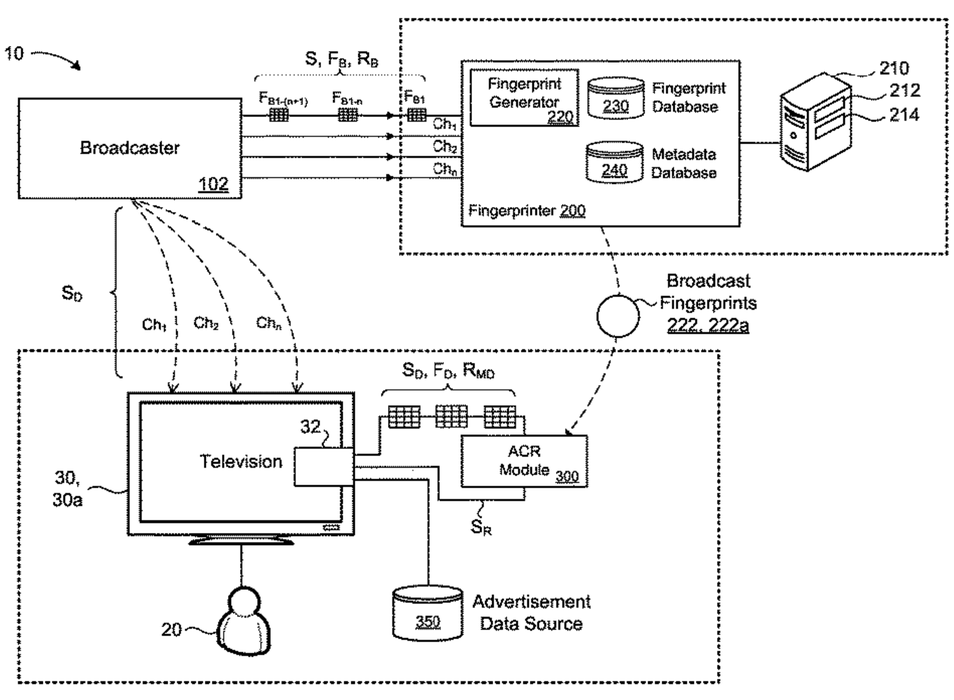
(57) **ABSTRACT**

A system and method includes operations and steps for inferring a demographic of a user based on a selection of an advertisement by the user. A media device stream is received from a media device by data processing hardware. The data processing hardware may identify frames of the media device stream for insertion of an overlay. The overlay can include first and second interactive portions corresponding to respective first and second advertisements. The user can select one of the first interactive portion and the second interactive portion corresponding to one of the first advertisement and the second advertisement. The selection can be received by the data processing hardware, and the demographic of the user can be inferred based on the selection.

20 Claims, 10 Drawing Sheets





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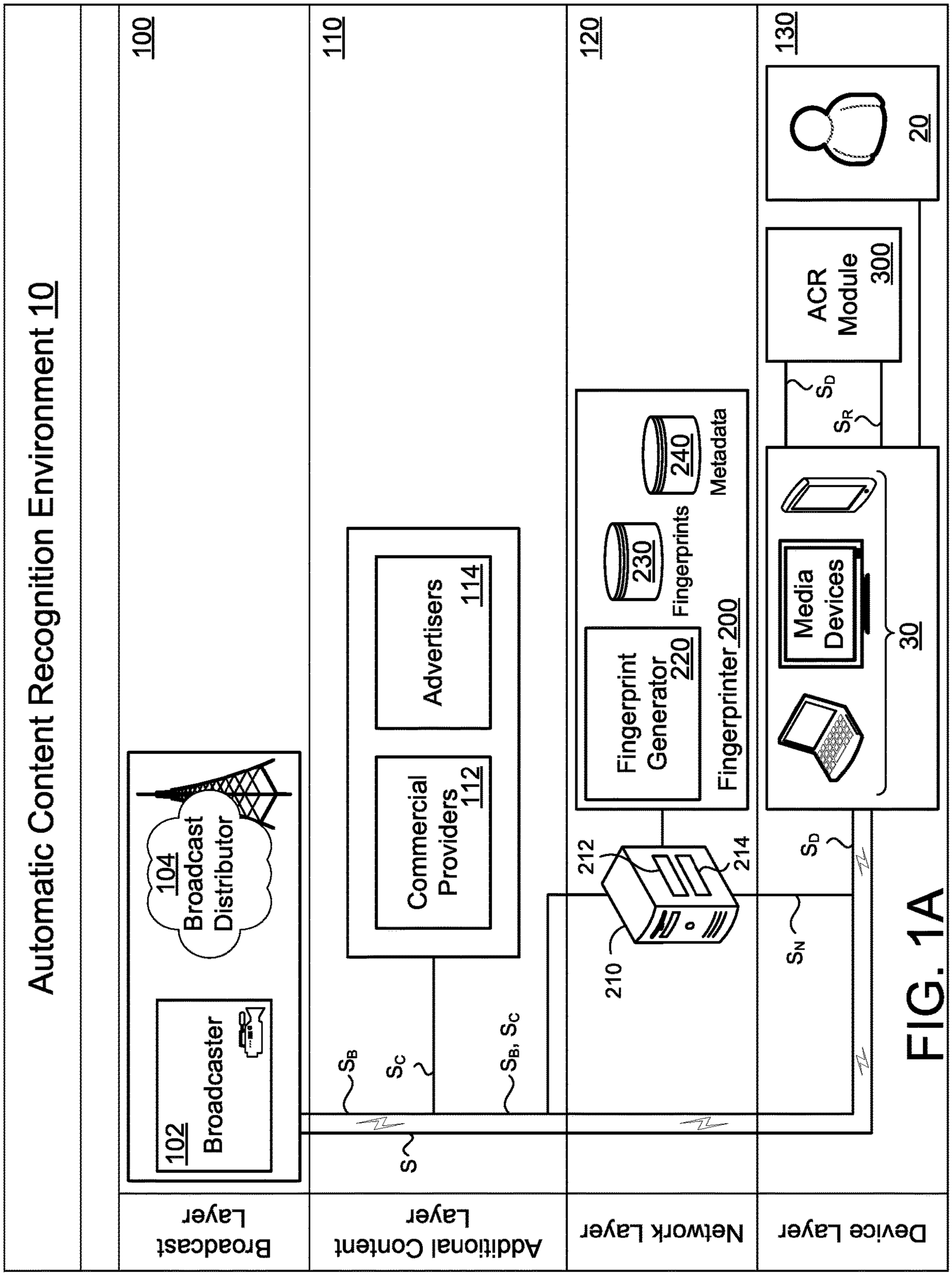
Automatic Content Recognition Environment 10
Broadcast Layer
Additional Content Layer
Network Layer
Device Layer
100
110
120
130
104
Broadcast Distributor
102
Broadcaster
Commercial Providers 112
Advertisers 114
Fingerprinter 200
Fingerprint Generator 220
230
Fingerprints
240
Metadata
212
214
210
20
ACR Module 300
Media Devices
30
S_B
S_C
S_B, S_C
S_D
S_R
S_N
S_D
S
1A

FIG. 1

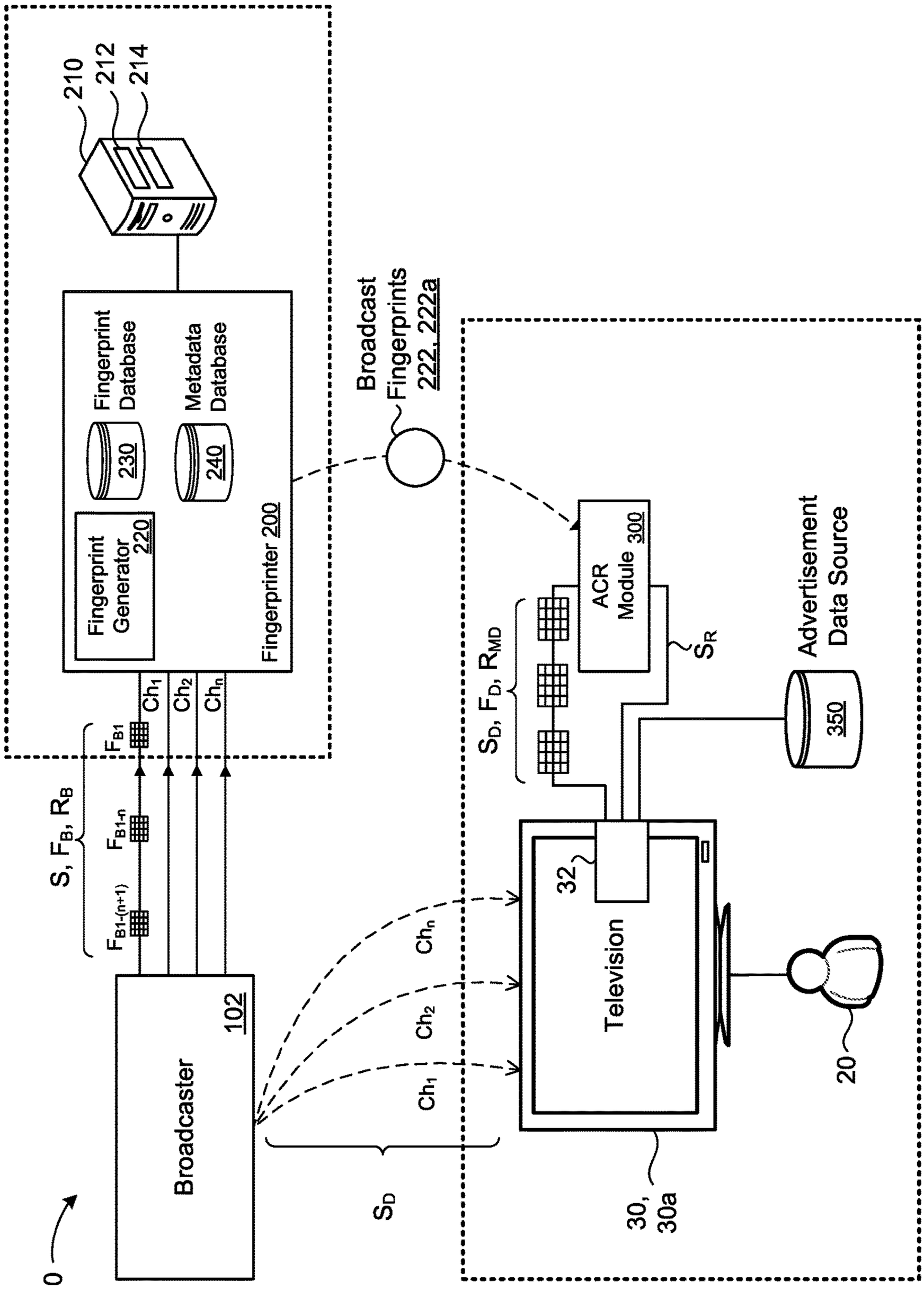
10
Broadcaster 102
S_D
Ch_1
Ch_2
Ch_n
30, 30a
Television
32
20
S_D, F_D, R_{MD}
ACR Module 300
S_R
Advertisement Data Source
350
Broadcast Fingerprints 222, 222a
Fingerprinter 200
Fingerprint Generator 220
Fingerprint Database 230
Metadata Database 240
S_B, F_B, R_B
F_{B1}
F_{B1-n}
$F_{B1-(n+1)}$
210
212
214

FIG. 1B

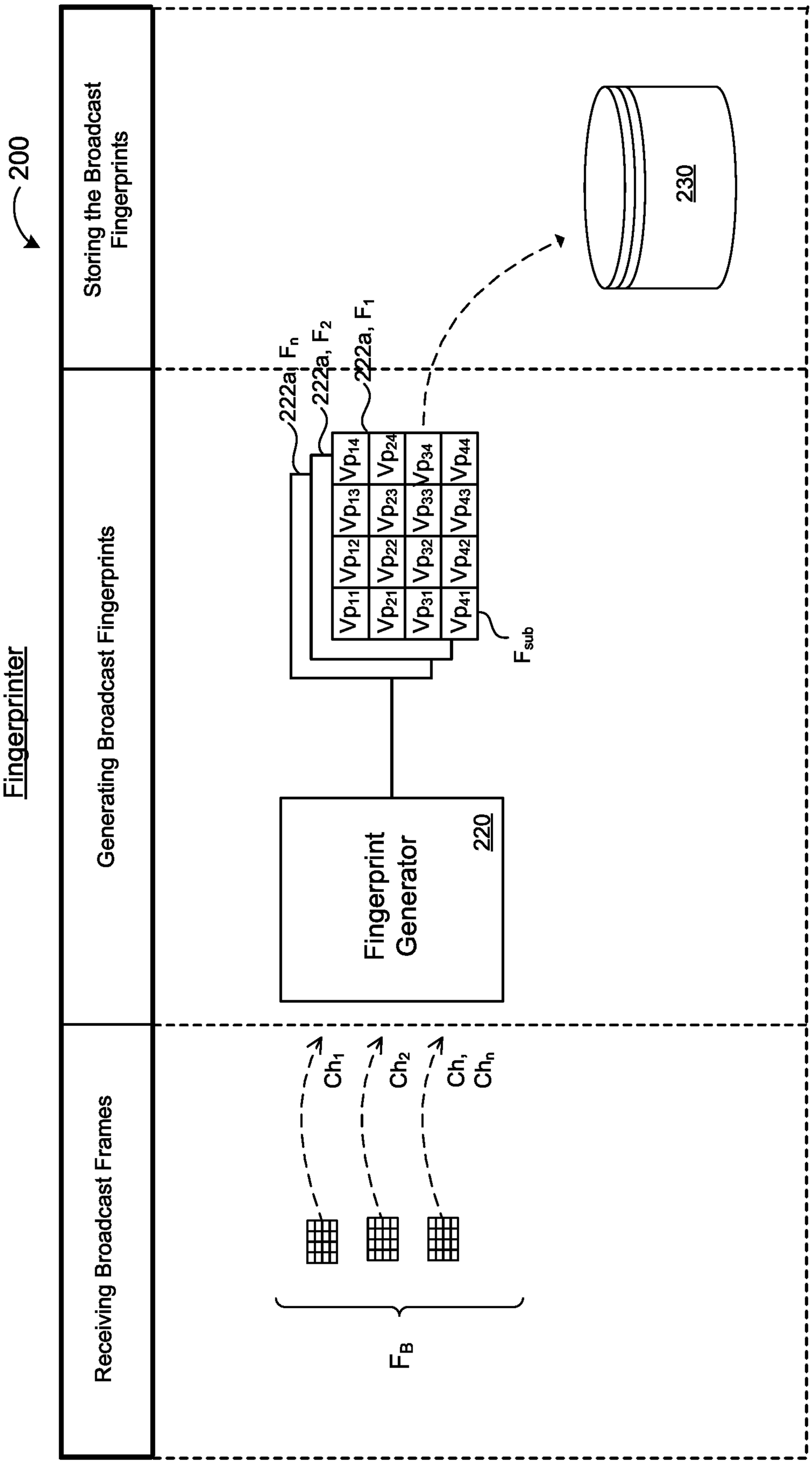
200
Storing the Broadcast Fingerprints
Fingerprinter
Generating Broadcast Fingerprints
230
222a, Fn
222a, F2
222a, F1
Vp14 Vp24 Vp34 Vp44
Vp13 Vp23 Vp33 Vp43
Vp12 Vp22 Vp32 Vp42
Vp11 Vp21 Vp31 Vp41
Fsub
Fingerprint Generator
220
Receiving Broadcast Frames
Ch1
Ch2
Ch, Chn
FB

FIG. 2

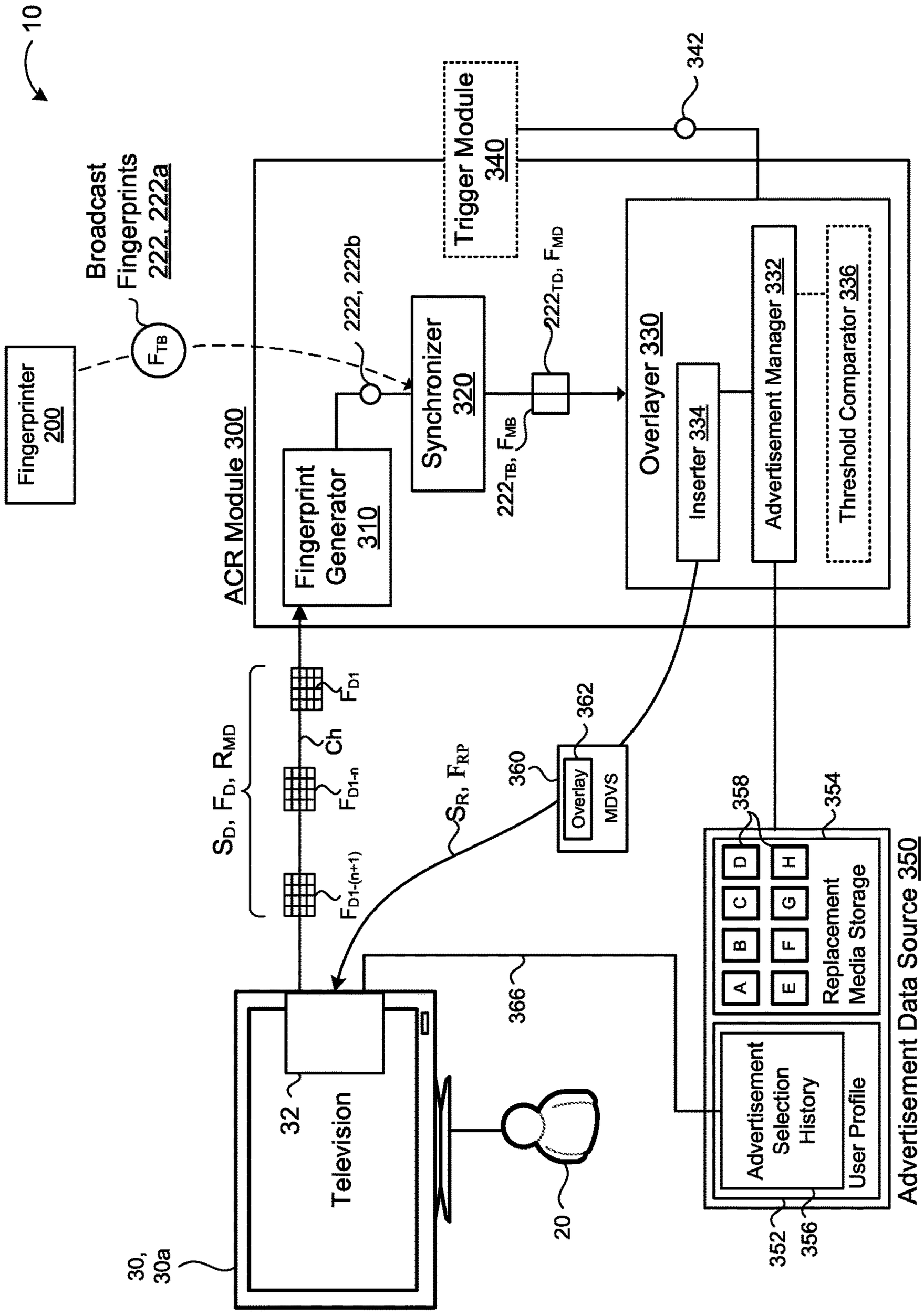
10
Broadcast Fingerprints 222, 222a
F_{TB}
Fingerprinter 200
ACR Module 300
Fingerprint Generator 310
222, 222b
Synchronizer 320
222_{TB}, F_{MB}
222_{TD}, F_{MD}
Trigger Module 340
342
Overlayer 330
Inserter 334
Advertisement Manager 332
Threshold Comparator 336
S_D, F_D, R_{MD}
F_{D1}
Ch
F_{D1-n}
$F_{D1-(n+1)}$
S_R, F_{RP}
360
362
Overlay MDVS
366
32
Television
30, 30a
20
Advertisement Data Source 350
Replacement Media Storage
A
B
C
D
E
F
G
H
358
354
Advertisement Selection History
User Profile
352
356

FIG. 3A

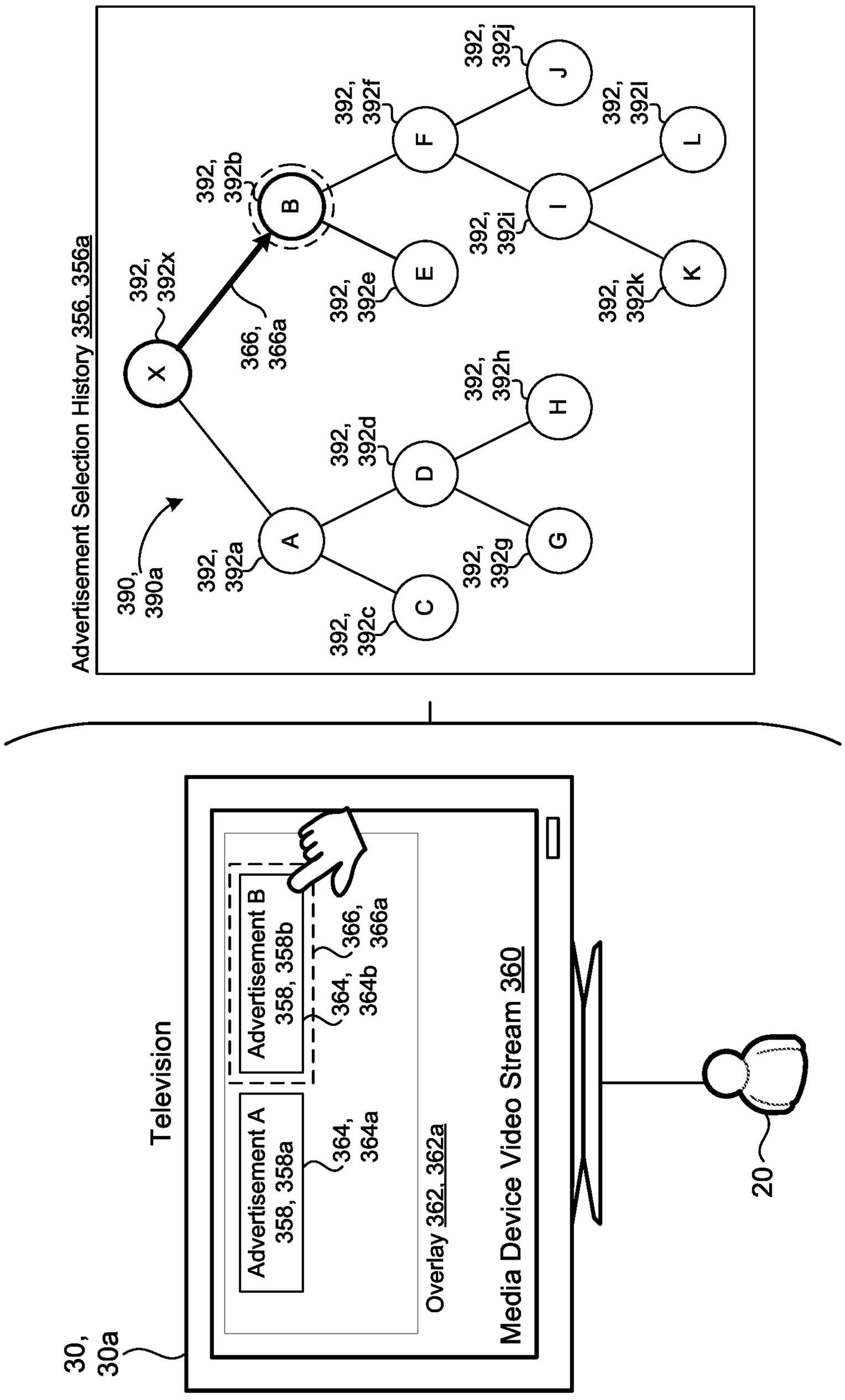
Advertisement Selection History 356, 356a
390, 390a
392, 392x
X
366, 366a
392, 392a
A
392, 392b
B
392, 392c
C
392, 392d
D
392, 392e
E
392, 392f
F
392, 392g
G
392, 392h
H
392, 392i
I
392, 392j
J
392, 392k
K
392, 392l
L
30, 30a
Television
Media Device Video Stream 360
Overlay 362, 362a
Advertisement A 358, 358a
364, 364a
Advertisement B 358, 358b
364, 364b
366, 366a
20

FIG. 3B

358, 358a

Advertiser:	The Advertiser
Code:	XYZ123456A
Title:	Advertisement A
Category:	Health and Beauty
Description:	This is an advertisement depicting The Advertiser's Product A.
Length:	00:30
Demographic Category	**Demographic Classification**
Target Gender:	Male
Target Age:	18–65
Target Race:	All
Target Income:	> $40,000

358, 358b

Advertiser:	The Advertiser
Code:	XYZ123456B
Title:	Advertisement B
Category:	Health and Beauty
Description:	This is an advertisement depicting The Advertiser's Product B.
Length:	00:30
Demographic Category	**Demographic Classification**
Target Gender:	Female
Target Age:	18–65
Target Race:	All
Target Income:	> $40,000

366, 366a

FIG. 3C

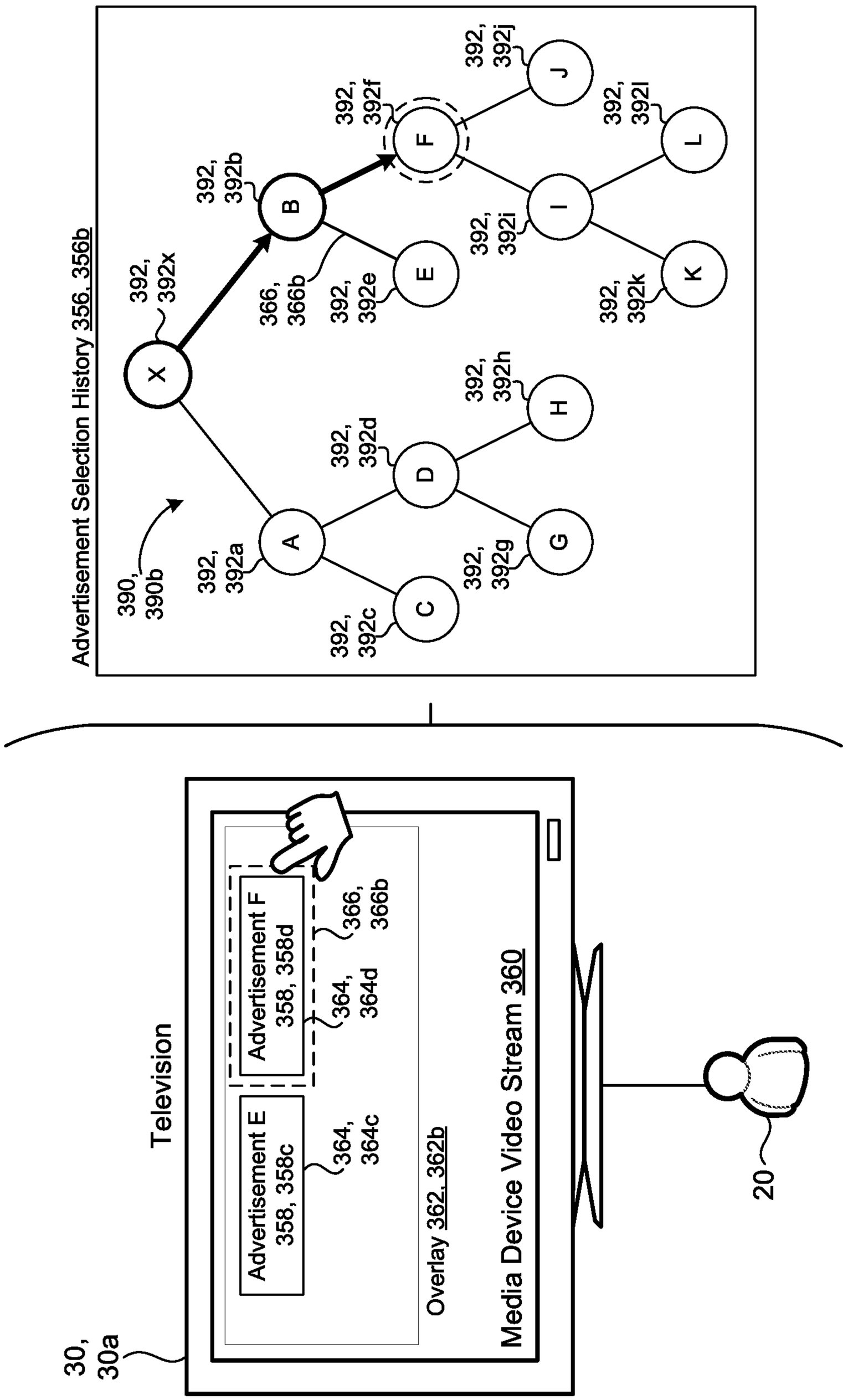
Advertisement Selection History 356, 356b
390, 390b
X
392, 392x
A
392, 392a
B
392, 392b
C
392, 392c
D
392, 392d
E
366, 366b
392, 392e
F
392, 392f
G
392, 392g
H
392, 392h
I
392, 392i
J
392, 392j
K
392, 392k
L
392, 392l
30, 30a
Television
Media Device Video Stream 360
Overlay 362, 362b
Advertisement E 358, 358c
364, 364c
Advertisement F 358, 358d
364, 364d
366, 366b
20

FIG. 3D

366, 366b

Advertiser:	The Advertiser
Code:	XYZ123456F
Title:	Advertisement F
Category:	Household
Description:	This is an advertisement depicting The Advertiser's Product F.
Length:	00:30
Demographic Category	**Demographic Classification**
Target Gender:	Female
Target Age:	32–54
Target Race:	All
Target Income:	> $40,000

358, 358d

358, 358c

Advertiser:	The Advertiser
Code:	XYZ123456E
Title:	Advertisement E
Category:	Householod
Description:	This is an advertisement depicting The Advertiser's Product E.
Length:	00:30
Demographic Category	**Demographic Classification**
Target Gender:	Male
Target Age:	32–54
Target Race:	All
Target Income:	> $40,000

FIG. 3E

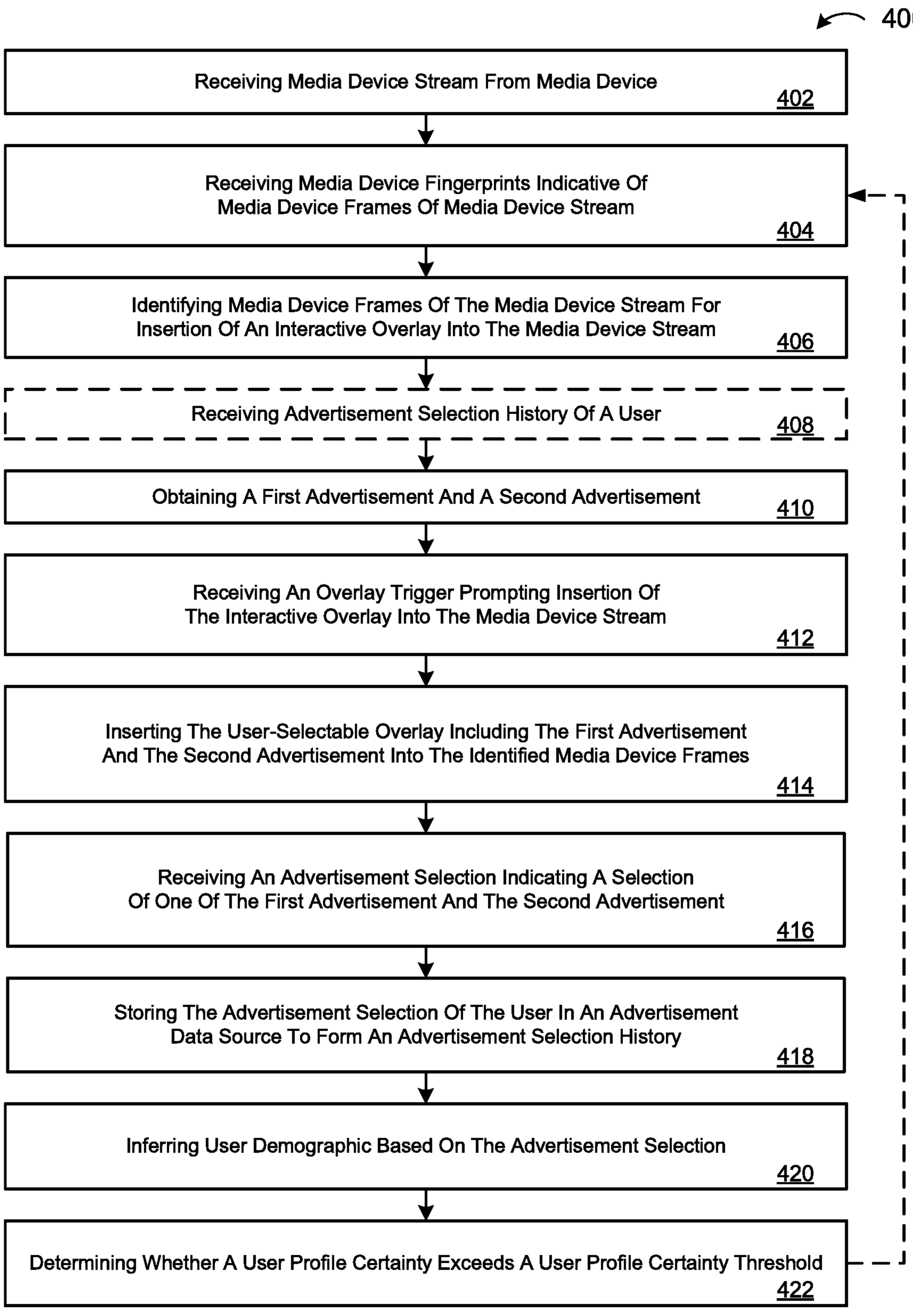
400
Receiving Media Device Stream From Media Device
402
Receiving Media Device Fingerprints Indicative Of Media Device Frames Of Media Device Stream
404
Identifying Media Device Frames Of The Media Device Stream For Insertion Of An Interactive Overlay Into The Media Device Stream
406
Receiving Advertisement Selection History Of A User
408
Obtaining A First Advertisement And A Second Advertisement
410
Receiving An Overlay Trigger Prompting Insertion Of The Interactive Overlay Into The Media Device Stream
412
Inserting The User-Selectable Overlay Including The First Advertisement And The Second Advertisement Into The Identified Media Device Frames
414
Receiving An Advertisement Selection Indicating A Selection Of One Of The First Advertisement And The Second Advertisement
416
Storing The Advertisement Selection Of The User In An Advertisement Data Source To Form An Advertisement Selection History
418
Inferring User Demographic Based On The Advertisement Selection
420
Determining Whether A User Profile Certainty Exceeds A User Profile Certainty Threshold
422

FIG. 4

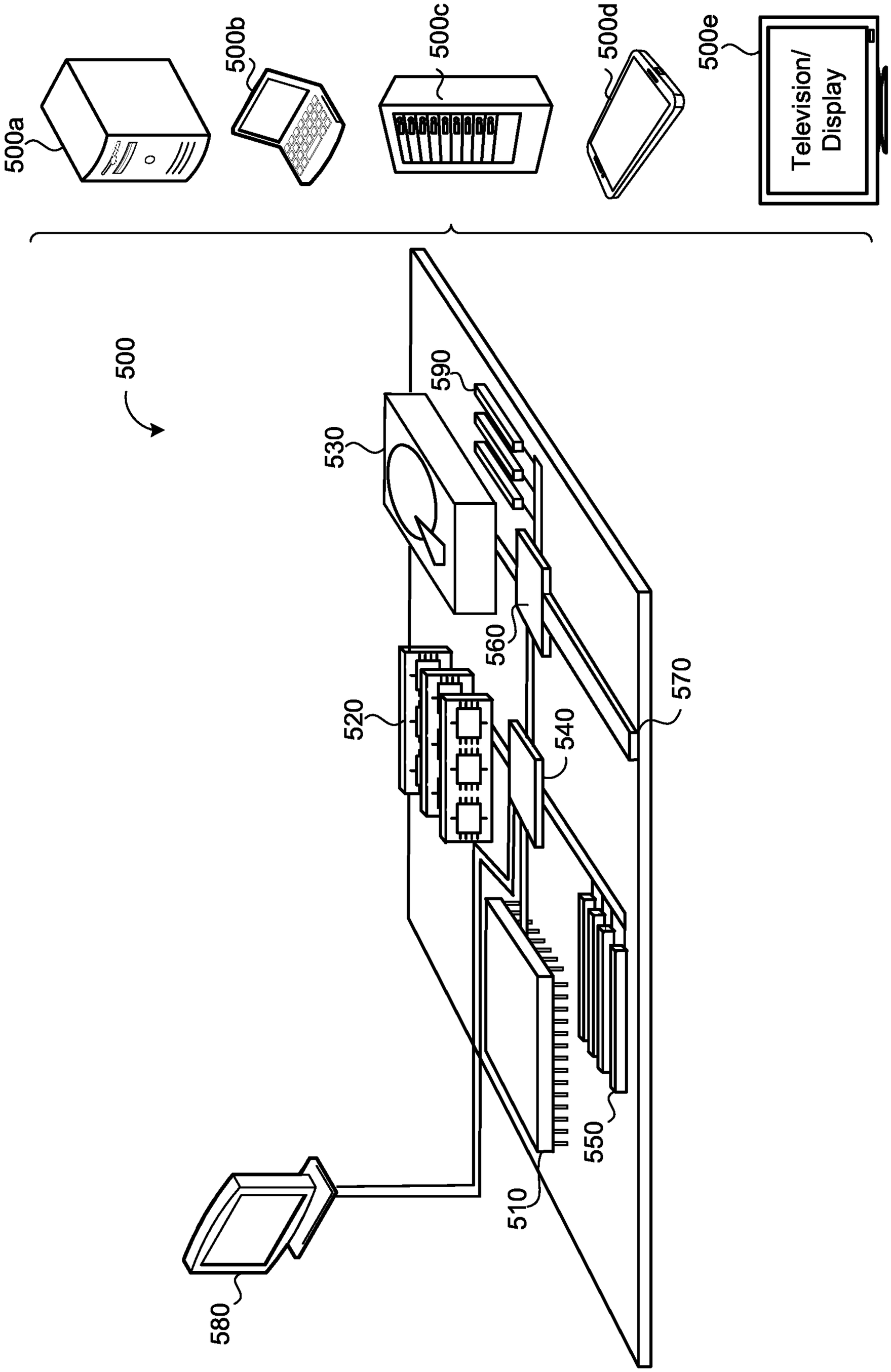
500a
500b
500c
500d
500e
Television/
Display
500
590
530
560
570
520
540
550
510
580

FIG. 5

OBTAINING VIEWER DEMOGRAPHICS THROUGH ADVERTISEMENT SELECTIONS

RELATED DISCLOSURES

This disclosure is a continuation of, and claims priority to, U.S. patent application Ser. No. 15/725,260 filed Oct. 4, 2017, which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

This disclosure relates to inferring viewer demographics based on advertisement choice.

BACKGROUND

Media devices today are becoming more and more common and may range from fixtures in a home, such as a television, to mobile devices traveling along with a media consumer. Media devices, such as televisions, set-top boxes, mobile phones, laptops, and tablets, may access and may retrieve media content from a variety of sources. For example, a media device may receive media content via satellite, over-the-air broadcasting, or streaming systems from a wired or a wireless connection. As the use of media devices continues to increase, media device connectivity to media content has also increased. With this growth, new media content markets have emerged and old media content market have adapted to understand and to provide contextually-relevant media content to the media consumer.

SUMMARY

A system and method include operations and steps for inferring a demographic of a user based on a selection of an advertisement by the user. A media device stream is received from a media device by data processing hardware. The data processing hardware may identify frames of the media device stream for insertion of an overlay. The overlay can include first and second interactive portions corresponding to respective first and second advertisements. The user can select one of the first interactive portion and the second interactive portion corresponding to one of the first advertisement and the second advertisement. The selection can be received by the data processing hardware, where the demographic of the user can be inferred.

One aspect of the disclosure provides a method. The method may include receiving, at data processing hardware, a media device stream from a corresponding media device. The data processing hardware may identify media device frames of the media device stream for insertion of an overlay comprising first and second advertisements. The data processing hardware inserts the overlay into the identified media device frames. The overlay comprises a first interactive portion corresponding to the first advertisement and a second interactive portion corresponding to the second advertisement. The data processing hardware receives an advertisement selection indicating a selection by a user of the media device of one of the first interactive portion of the overlay, which corresponds to the first advertisement, or the second interactive portion of the overlay, which corresponds to the second advertisement. The data processing hardware infers a demographic of the user based on the advertisement selection of the user.

Implementations of the disclosure may include one or more of the following optional features. For example, the

data processing hardware may receive an advertisement selection history of the user, and obtain the first advertisement and/or the second advertisement from an advertisement data sources based on the advertisement selection history.

In some implementations, the data processing hardware may store the advertisement selection of the user in the advertisement data source. The first advertisement may correspond to a first leaf node of a binary tree, and the second advertisement may correspond to a second leaf node of the binary tree. The second leaf node may share a common parent node with the first leaf node. The binary tree may comprise a plurality of leaf nodes, whereby each leaf node has a corresponding advertisement, and each advertisement has a corresponding demographic. The common parent node corresponds to an advertisement associated with a previous advertisement selection of the user.

In some examples, the first advertisement corresponds to a first demographic classification within a first demographic category, and the second advertisement corresponds to a second demographic classification within a second demographic category.

In some implementations, the data processing hardware receives an overlay trigger prompting the insertion of the overlay into the media device stream.

In some examples, the step of identifying the media device frames of the media device stream may include receiving, at the data processing hardware, broadcast fingerprints indicative of broadcast frames of a broadcast media stream. The data processing hardware may receive media device fingerprints indicative of media device frames of the media device stream at the corresponding media device, and determine a frame match between the media device frames of the media device stream relative to the broadcast frames of the broadcast media stream. At least some of the broadcast frames and/or the media device frames may correspond to advertisement frames.

In some implementations, inferring the demographic of the user comprises comparing a user profile certainty with a user profile certainty threshold

Another aspect of the disclosure provides a system including data processing hardware and memory hardware. The memory hardware is in communication with the data processing hardware, and stores instructions that, when executed on the data processing hardware, cause the data processing hardware to perform operations. One of the operations may include receiving a media device stream from a corresponding media device. Another operation can include identifying media device frames of the media device stream for insertion of an overlay comprising first and second advertisements. Yet another operation can include inserting the overlay into the identified media device frames, the overlay comprising a first interactive portion corresponding to the first advertisement and a second interactive portion corresponding to the second advertisement. Another operation may include receiving an advertisement selection indicating a selection by a user of the media device of one of the first interactive portion of the overlay, which corresponds to the first advertisement, or the second interactive portion of the overlay, which corresponds to the second advertisement. Yet another operation may include inferring a demographic of the user based on the advertisement selection of the user.

This aspect may include one or more of the following optional features. For example, additional operations performed may include receiving an advertisement selection history of the user, and obtaining the first advertisement

and/or the second advertisement from an advertisement data source based on the advertisement selection history. The operations may also include storing the advertisement selection of the user in the advertisement data source. The first advertisement may correspond to a first leaf node of a binary tree and the second advertisement may correspond to a second leaf node of the binary tree. The second leaf node may share a common parent node with the first leaf node. The binary tree may comprise a plurality of the leaf nodes, whereby each leaf node has a corresponding advertisement, and each advertisement having a corresponding demographic. The common parent node may correspond to an advertisement associated with a previous advertisement selection of the user.

In some implementations, the operations may further comprise receiving an overlay trigger prompting the insertion of the overlay into the media device stream.

In some examples, the operation of identifying the media device frames of the media device stream may include receiving, at the data processing hardware, broadcast fingerprints indicative of broadcast frames of a broadcast media stream. The data processing hardware may receive media device fingerprints indicative of media device frames of the media device stream at the corresponding media device, and determine a frame match between the media device frames of the media device stream relative to the broadcast frames of the broadcast media stream. At least some of the broadcast frames and/or the media device frames may correspond to advertisement frames.

In other examples, at least some of the broadcast frames and/or the media device frames may correspond to advertisement frames.

In other implementations, the operation of inferring the demographic of the user may comprise comparing a user profile certainty with a user profile certainty threshold.

The details of one or more implementations of the disclosure are set forth in the accompanying drawings and the description below. Other aspects, features, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. **1**A is a schematic view of an example of an automatic content recognition environment.

FIG. **1**B is a schematic view of an example of an automatic content recognition environment.

FIG. **2** is a schematic view of an example server of the automatic content recognition environment.

FIG. **3**A is a schematic view of an example of an automatic content recognition environment.

FIG. **3**B is a schematic view of an example automatic content recognition module corresponding to a media device.

FIG. **3**C is a schematic view of a first example advertisement and a second example advertisement.

FIG. **3**D is a schematic view of an example automatic content recognition module corresponding to a media device.

FIG. **3**E is a schematic view of a third example advertisement and a fourth example advertisement.

FIG. **4** is a flow diagram for an example method for inferring user demographic information based on an advertisement selection.

FIG. **5** is a schematic view of an example computing device that may be used to implement the systems and methods described herein.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Generally, automatic content recognition (ACR) is the process of identifying media content on a media device or within a media file. ACR has become increasingly useful to identify vast amounts of media content consumed by society every day. From a commercial perspective, ACR may allow businesses and other entities to understand media content consumption and, perhaps more effectively, to market or to target consumers (i.e. media device users) of the media content. For example, an advertisement or an offer is likely more effective when the advertisement is personalized to the user of a media device. Accordingly, broadcasters, commercial providers, advertisers and other entities want to know what programs are being viewed or, more particularly, where the user is in the program during viewing. With this type of information, the media device user may receive more precisely catered media content.

FIG. **1**A is an example of an automatic content recognition (ACR) environment **10**. The ACR environment **10** may include several layers to distribute media content to a user **20** (i.e., a viewer) of a media device **30**. FIG. **1**A attempts to simplify the media content distribution process into four layers: a broadcast layer **100**; an additional content layer **110**; a network layer **120**; and a device layer **130**. Each layer **100**, **110**, **120**, **130** may have entities that influence a media stream S. The broadcast layer **100** represents broadcast entities that may be involved in producing a broadcast media stream S_B. These broadcast entities may include a broadcaster **102** and a broadcast distributor **104**. The broadcaster **102** may be one or more media content providers, such as local broadcasters, multi-channel networks, or other media content owners. The broadcast distributor **104** is a broadcast entity that provides infrastructure or resources (e.g., signal wires, communication towers, communication antennas, servers, etc.) to distribute media content. The broadcaster **102** and the broadcast distributor **104** may be the same broadcast entity or a different broadcast entity depending on broadcasting variables, such as a type of media content being provided or a type of media device receiving the media content.

In some implementations, the media stream S includes an additional media content stream S_C from content entities represented as the additional content layer **110**. These content entities include commercial providers **112**, advertisers **114**, or other entities contributing additional media content to the media stream S. Generally, commercial providers **112** are content entities that procure and/or host the additional media content stream S_C, while advertisers **114** are content entities that generate the additional media content stream S_C, such as advertisements, offers, deals, discounts, benefits, or other promotions of goods and/or services. Additionally or alternatively, the commercial providers **112** and the advertisers **114** may be the same content entity. The additional content layer **110** may communicate the additional media content stream S_C to the broadcast layer **100**, the network layer **120**, the device layer **130**, or any combination thereof. Optionally, the additional content layer **110** may pair the additional media content stream S_C with the broadcast media stream S_B to form the media stream S that includes the broadcast media stream S_B and the additional media content stream S_C.

Referring further to FIG. **1**A, the network layer **120** is configured to receive the broadcast media stream S_B and the

additional media content stream S_C from the broadcast layer **100** and/or the additional content layer **110**. For example, if the network layer **120** receives the media stream S from the broadcast layer **100**, the network layer **120** may receive the broadcast media stream S_B with the additional media content S_C or independent of the additional media content stream S_C. Similarly, if the network layer **120** receives the media stream S from the additional content layer **110**, the network layer **120** may receive the broadcast media stream S_B with the additional media content stream S_C or independent of the additional media content stream S_C. In some implementations, the network layer **120** may pair the broadcast media stream S_B from the broadcast layer **100** with the additional media content stream S_C from the additional content layer **110** to generate a network media stream S_N representing the broadcast media stream S_B impregnated with the additional media content stream S_C.

The network layer **120** includes a fingerprinter **200**. The fingerprinter **200** is configured to operate on a server **210** having data processing hardware **212** and memory hardware **214**. The fingerprinter **200** includes a broadcast fingerprint generator **220**. The network layer **120** may be configured to store fingerprints **222** and metadata related to the fingerprints **222** in a fingerprint database **230** and/or a metadata database **240**. Generally, a fingerprint **222** is at least one unique identifier corresponding to at least one frame F_n of the media stream S. For example, the at least one unique identifier may be a value (e.g., pixel value), an alphanumeric representation, or a compressed version of the audio visual image. Additionally or alternatively, the network layer **120** is configured to store the broadcast media stream S_B, the additional media content stream S_C, or both.

The device layer **130** includes one or more media devices **30** and an automatic content recognition (ACR) module **300**. The ACR module **300** may be an internal device to the television **30**, **30***a* (e.g., hardware or software of the television **30**, **30***a*) or an external device in communication with the television **30**, **30***a* (e.g., a headend system or a set top box). The media devices **30**, such as televisions, PCs, laptops, tablets, or mobile phones, receive a media device stream S_D (e.g., any combination of the broadcast media stream S_B, the additional content stream S_C, or the network media stream S_N) and may convey all or a portion of the corresponding media device stream S_D to a user **20**.

A device may mean any hardware or any software related to a media device **30** configured to receive or to communicate some form of media content. In some implementations, the media devices **30** and more specifically, the ACR module **300**, may be configured to interpret or to interact with the corresponding media stream S (e.g., any combination of the broadcast media stream S_B, the additional content stream S_C, or the network media stream S_N). For example, the ACR module **300** identifies the additional media content stream S_C from the broadcast media stream S_B. The ACR module **300** may substitute or overlay the additional media content stream S_C of the media device stream S_D with a replacement media content stream S_R. The ACR module **300** may filter the media device stream S_D for predefined content. Additionally or alternatively, the media devices **30** and the ACR module **300** may be configured to communicate information or data related to the media device stream S_D with the broadcast layer **100**, the additional content layer **110**, the network layer **120**, or other media devices **30** of the device layer **130**.

FIG. **1**B is an example of the ACR environment **10**. The ACR environment **10** includes the broadcaster **102**, the fingerprinter **200**, the media device **30**, the ACR module **300**, and an advertisement data source **350**. The broadcaster **102** broadcasts the media stream S by channels Ch_{1-n} to the fingerprinter **200** at a broadcast frame rate R_B. The broadcast frame rate R_B divides the media stream S into broadcast frames F_B such that each broadcast frame F_B corresponds to an audio visual image represented by pixels within the media stream S. The fingerprinter **200** is configured to receive each broadcast frame F_B at the broadcast fingerprint generator **220**. The broadcast fingerprint generator **220** receives each broadcast frame F_B and is configured to generate broadcast fingerprints **222**, **222***a* indicative of each broadcast frame F_B. Generally, as mentioned earlier, a broadcast fingerprint **222**, **222***a* is at least one unique identifier corresponding to at least one broadcast frame F_B. The fingerprinter **200** may store each broadcast fingerprint **222**, **222***a* in a database, such as the fingerprint database **230**. In some examples, the fingerprinter **200** stores each broadcast fingerprint **222**, **222***a* according to or along with metadata corresponding to the broadcast frame F_B, such as a frame location F_{B1-n} (e.g., a frame time code), a type of frame (e.g., live program or advertisement), or a fingerprint identifier tag. In other examples, the fingerprinter **200** has one or more separate metadata databases **240** corresponding to the metadata of each broadcast fingerprints **222**, **222***a*. The separate metadata database **240** for metadata may allow the fingerprinter **200** to store more broadcast fingerprints **222**, **222***a*.

Referring further to FIG. **1**B, the media device **30** receives the media stream S from the broadcaster **102** as a media device stream S_D. The media device **30** is configured to capture media frames F_D from the media device stream S_D and to communicate the captured media frames F_D to the ACR module **300**. In the example shown in FIG. **1**B, the media device **30** is a television **30**, **30***a* (TV) that receives the media device stream S_D. For example, the television **30**, **30***a* receives television channels Ch_{1-n} as the media device stream S_D.

In some implementations, the broadcaster **102** provides the media stream S at the broadcast frame rate R_B. Often, the broadcast frame rate R_B corresponds to various industry standards of a broadcast format (e.g., 1080 60i, 720 60P, etc.). For example, some common broadcast frame rates R_B include 30P (29.97 frames per second), 24P, (23.98 frames per second), and 60P (59.94 frames per second). The television **30**, **30***a* may be configured to capture frames F_D of the media device stream S_D at a media device frame rate R_{MD}. The media device frame rate R_{MD} is the frame rate at which a corresponding television **30**, **30***a* provides captured frames F_D to the ACR module **300**. In some implementations, the television **30**, **30***a* is configured to receive the media device stream S_D at the broadcast frame rate R_B, but yet be configured to capture frames F_D of the media device stream S_D at a media device frame rate R_{MD} for the ACR module **300**. For example, the broadcast frame rate R_B is different than the media device frame rate R_{MD}. An example of this difference is that the broadcast frame rate R_B is greater than the media device frame rate R_{MD} (e.g., a broadcast frame rate of 30P and a media device frame rate R_{MD} of 4 frames per second). The difference in frame rates may be resource limitations (processor, memory, etc.) relating to frame capturing hardware or software at the television **30**, **30***a*.

In some examples, the ACR module **300** receives broadcast fingerprints **222**, **222***a* from the fingerprinter **200** and the media device frames F_D from the media device stream S_D. The ACR module **300** may compare the media device frames F_D to the broadcast frames F_B to identify matching frames F_{Bn}, F_{Dn} so that a replacement media content stream S_R can be substituted for the media device stream S_D.

FIG. **2** illustrates example operations of the broadcast fingerprint generator **220** of the fingerprinter **200**. The broadcast fingerprint generator **220** receives the broadcast frames F_B corresponding to channels Ch_{1-n} of the media stream S. The broadcast fingerprint generator **220** may generate a broadcast fingerprint **222**, **222***a* for each received broadcast frame F_B and may store the broadcast fingerprint **222**, **222***a* in the fingerprint database **230**. In some examples, each broadcast fingerprint **222**, **222***a* represents at least one pixel value V_P of the broadcast frame F_B of the corresponding media stream S. The at least one pixel value V_P may be an average pixel value or a sum of color space values of the broadcast frame F_B. For example, the at least one pixel value V_P may represent a sum and/or average of grayscale values of a corresponding broadcast frame F_B when the broadcast fingerprint generator **220** generates a broadcast fingerprint **222**, **222***a* according to a gray-UV (YUV) color space. In other words, each pixel of the corresponding broadcast frame F_B is represented by a grayscale value such that the broadcast fingerprint **222**, **222***a* represents the sum and/or average of the grayscale values of a pixel area. In some implementations, the fingerprint **222** (e.g., the broadcast fingerprint **222**, **222***a*) is a unique identifier based on sub-frames F_{sub} of the corresponding broadcast frame F_B. Depending on the pixels per sub-frame F_{sub}, each sub-frame F_{sub} may have a corresponding pixel value V_p or a corresponding average pixel value.

FIG. **2** also illustrates an example of a broadcast fingerprint **222***a*, F_{1-n} corresponding to a broadcast frame F_B divided into sub-frames F_{sub}. In some examples, the broadcast fingerprint generator **220** divides each broadcast frame F_B into sub-frames F_{sub} to more accurately compare or to distinguish between broadcast frames F_B. With sub-frames F_{sub}, each fingerprint **222** may represent more than one average pixel value V_p of the corresponding frame F_B. By dividing each broadcast frame F_B into sub-frames F_{sub}, more details (e.g., pixels of each sub-frame F_{sub}) are taken into account during broadcast fingerprint generation than broadcast fingerprints **222**, **222***a* based on a pixel value V_P (or average pixel value) of an entire broadcast frame F_B. As such, the number of sub-frames F_{sub} that the broadcast fingerprint generator **220** divides each broadcast frame F_B into depends on a desired level of accuracy. For example, as shown in FIG. **2**, the broadcast fingerprint generator **220** divides each broadcast frame F_B into sixteen sub-frames F_{sub} defining a four by four array. Each sub-frame F_{sub} of the sixteen sub-frames F_{sub} has an average pixel value V_{p11-44} such that each broadcast fingerprint **222**, **222***a* represents each corresponding broadcast frame F_B by a sixteen value integer vector having an integer value associated with each sub-frame F_{sub}. Although the figures may depict each broadcast frame F_B or each media device frame F_D as a four by four array, any sub-frame division is possible.

FIG. **3**A shows an example of the ACR environment **10**, detailing a relationship between the television **30**, **30***a*, the fingerprinter **200**, the ACR module **300**, and the advertisement data source **350**. As discussed above, the television **30**, **30***a* may be configured to receive and convey all or a portion of the media device stream S_D and the replacement media content stream S_R. The television **30**, **30***a* may include a content manager **32** configured to communicate with the ACR module **300** and/or the advertisement data source **350**. The content manager **32** may be an internal device to the television **30**, **30***a* (e.g., hardware or software of the television **30**, **30***a*) or an external device in communication with the television **30**, **30***a* (e.g., a headend system or a set top box). The content manager **32** can be a server component that receives the replacement media content stream S_R from the ACR module **300**, displays the replacement media content stream S_R on the television **30**, **30***a*, and records an impression or association between the replacement media content stream S_R and the user **20** in the advertisement data source **350**, as discussed further herein.

The ACR module **300** is configured to determine a frame match between the media device frames F_D of a media device stream S_D relative to the broadcast frames F_B of a broadcast media stream S_B, S_C. In some examples, the ACR module **300** includes a fingerprint generator **310** and a synchronizer **320**. The fingerprint generator **310** functions similar to the broadcast fingerprint generator **220**, except that the fingerprint generator **310** of the ACR module **300** generates fingerprints **222** (i.e., media device fingerprints **222**, **222***b*) corresponding to media device frames F_D captured at a media device **30** (e.g., the TV **30**, **30***a*). The fingerprint generator **310** is configured to communicate the media device fingerprints **222**, **222***b* to the synchronizer **320**.

In some implementations, the synchronizer **320** receives the media device fingerprints **222**, **222***b* and the broadcast fingerprints **222**, **222***a* from the fingerprinter **200**. With the media device fingerprints **222**, **222***b* and the broadcast fingerprints **222**, **222***a*, the synchronizer **320** identifies the frame match. The frame match is a broadcast frame F_B that matches a given media device frame F_D. Additionally or alternatively, the broadcast frame F_B that corresponds to the frame match is also referred to as a matching broadcast frame F_{MB}, while the media device frame F_D corresponding to the frame match is referred to as the matched media device frame F_{MD}. The ACR module **300** may identify parameters of the media content at the media device stream S_D based on the matching broadcast frame F_{MB}. For example, with the frame match, the ACR module **300** may identify metadata from the matching broadcast frame F_{MB}. The metadata may include a frame location (e.g., frame time code), a type of frame (e.g., live program or advertisement), a channel corresponding to the matching broadcast frame F_{MB}, an identifier tag, or any descriptor related to the matching broadcast frame F_{MB}. The ACR module **300** may associate the metadata from the matching broadcast frame F_{MB} with the matched media device frame F_{MD} of the frame match. In some examples, the ACR module **300** associates metadata regarding a channel Ch corresponding to the media device frame F_D and/or a media device frame location F_{D1-n} within the channel Ch (e.g., a frame time code).

With knowledge of the channel Ch and the position of the media device stream S_D at the media device **30**, broadcasters **102** and additional content providers **112**, **114** may know what program a user **20** is watching and where the user **20** is in the sequence of the program. The broadcaster **102** and the additional content providers **112**, **114** may then use such information to accurately target the user **20** for advertisements and offers or provide non-commercial information to the user **20** (e.g., news alerts, announcements, educational information, etc.). Thus, the ACR module **300** may allow an entity to coordinate media content provided to the user **20** during use of a media device **30**.

A potential problem with the frame match process at the ACR module **300** is that consecutive media device frames F_D may be very similar, such that consecutive media device frames F_D only have slight changes over time unless a scene change occurs drastically changing consecutive media device frames F_D. Due to only slight changes between consecutive media device frames F_D, the ACR module **300** may be at risk of falsely identifying a frame match. In other words, when the ACR module **300** determines that the media

device stream S_D is being viewed by the user **20** at one media device frame F_{D1} (a matched media device frame F_{MD}), the user **20** is actually viewing media content from the media device stream S_D a few media device frames F_D ahead of or behind the matched media device frame F_{MD}.

To address the potential of a matching error, the ACR module **300** is configured to determine a frame certainty metric as an indicator of whether the frame match corresponds to a media device frame F_D that best matches the matching broadcast frame F_{MB}. In other words, the ACR module **300** may determine that the frame match should shift to a different media device frame F_D than the original match media device frame F_{MD}.

The ACR module **300** may further include an overlayer **330** having an advertisement manager **332** and an inserter **334**. Generally, the overlayer **330** may identify media device frames F_D representing advertisements or flagged content within the media device stream S_D and may replace (or overlay) the media device frames F_D of media device stream S_D with replacement frames F_{RP} of the replacement media content stream S_R, including replacement advertisements **358**. More specifically, the replacement media content stream S_R may include an overlay **362** provided to the television **30**, **30***a*. In some examples, the overlay **362** is provided to the television **30**, **30***a* over top of a media device video stream **360** of the media device stream S_D, whereby the replacement frames F_{RP} including the overlay **362** are provided simultaneously with the media device stream S_D. The overlay **362** may be provided as an interactive overlay **362**. The interactive overlay **362** solicits feedback from the user **20**, and an impression or response from the user **20** can be received and recorded by the content manager **32**.

The advertisement manager **332** may be configured to choose one or more advertisements from the advertisement data source **350** to be provided as the replacement media content stream S_R, as discussed further, below. The advertisements **358** chosen by the advertisement manager **332** may be formatted by the advertisement manager **332** to be included within the overlay **362**.

The inserter **334** is in communication with the advertisement manager **332** and the media device **30**, and is configured to substitute or overlay the media device stream S_D with the replacement media content stream S_R including the advertisements **358** identified by the advertisement manager **332**. The inserter **334** may use information communicated from the synchronizer **320** to identify a media device frame F_D corresponding to an advertisement **358** within the media device stream S_D. For example, as the synchronizer **320** identifies a target media device fingerprint **222**, $\mathbf{222}_{TD}$ matching a target broadcast fingerprint **222**, $\mathbf{222}_{TB}$, the synchronizer **320** communicates the target media device fingerprint **222**, $\mathbf{222}_{TD}$ or the media device frame F_D corresponding to the target media device fingerprint **222**, $\mathbf{222}_{TD}$ to the inserter **334**. In some examples, the synchronizer **320** communicates metadata (e.g., a frame location $F_{D1\text{-}n}$) associated with the media device frame F_D corresponding to the target media device fingerprint **222**, $\mathbf{222}_{TD}$ such that the inserter **334** may align a set of the replacement frames F_{RP} of the replacement media content stream S_R with media device frames F_D to be replaced. Specifically, the inserter **334** may align a set of replacement frames F_{RP} including the overlay **362** with media device frames F_D corresponding to the additional media content stream S_C (i.e., advertisements). Additionally or alternatively, the inserter **334** may align a set of replacement frames F_{RP} including the overlay **362** with media device frames F_D corresponding to the broadcast media stream S_B, such as a television or movie broadcast, whereby the overlay **362** is displayed to the user **20** in advance of the additional media content stream S_C.

The overlayer **330** may further include a threshold comparator **336**. The threshold comparator **336** minimizes iterations of user profile development performed by the ACR environment **10** by determining when a user profile certainty satisfies a predetermined threshold. By minimizing the iterations, the ACR environment **10** may process more quickly and rely on less processing power. The threshold comparator **336** may be configured with a user profile certainty threshold to be compared to a user profile certainty after each iteration. With the user profile certainty threshold, the ACR module **300** does not have to continue developing the user profile indefinitely. For example, if the user profile certainty satisfies the user profile certainty threshold, the advertisement manager **332** discontinues the user profile development and stores the user profile **352** in the advertisement data source **350** for future use.

The ACR module **300** may include a trigger module **340** configured to prompt the ACR module **300** to insert the overlay **362** into the media device stream S_D based on the occurrence of a predetermined event. For example, the user **20** may flag specific media device frames F_D that he/she does not want to be displayed, such as media device frames F_D including graphic or irrelevant media content. When the ACR module **300** recognizes that the flagged media device frames F_D are going to be displayed, the trigger module **340** sends a trigger **342** to the overlayer **330**, prompting the overlayer **330** to provide the replacement media content stream S_R in place of the media device stream S_D. The ACR module **300** may identify media device frames F_D based on the metadata provided with the broadcast frames F_B.

In some examples, the media device **30** and the ACR module **300** can be coupled to the advertisement data source **350**. The advertisement data source **350** can store one or more of the user profiles **352**, which may include associated advertisement selection histories **356** based on the impressions received from the content manager **32**. The advertisement data source **350** may include a replacement media storage **354** configured to store replacement media content, such as advertisements **358**, to be included in the replacement media content stream S_R. Although the replacement media content is generally discussed as including advertisements **358**, the replacement media content may include any type of media content. Alternatively, the replacement media storage **354** may be independent of the advertisement data source **350**.

Generally, when the overlayer **330** determines that the media device stream S_D should be replaced or overlaid with the replacement media content stream S_R, the advertisement manager **332** may communicate with the content manager **32** to identify a user profile **352** associated with the media device stream S_D, so that the replacement media content stream S_D can be tailored to the user **20**. The user profile **352** may be identified based on a manual selection of the user profile **352** by the user **20**. Alternatively, the user profile **352** may be identified automatically by the content manager **32**. For example, the content manager **32** may recognize particular viewing habits associated with a specific user **20**. Alternatively or additionally, the media device **30** may rely on geolocation to identify that a known user **20** is likely viewing the media device stream S_D. Based on the identified user profile **352**, or lack thereof, the advertisement manager **332** of the overlayer **330** can generate and submit a query or search of the replacement media storage **354** for media content to be included in the overlay **362**.

In some examples, no user profile **532** may be associated with the media device stream S_D. When no user profile **532** is associated with the media device stream S_D, the content manager **32** executes a first iteration of user profile development, as illustrated in FIGS. **3**B and **3**C. In additional examples, the user profile **532** may be partially developed, whereby the user profile certainty does not satisfy the user profile certainty threshold, and the user profile **532** requires further development, as illustrated in FIGS. **3**B and **3**C. In yet further examples, the user profile **532** associated with the media device stream S_D may be fully developed, whereby the user profile certainty satisfies the user profile certainty threshold, and no further development is necessary.

FIGS. **3**B-**3**E illustrate a first iteration and a second iteration of an example method for developing a user profile **352** using the ACR environment **10**. In the example shown, a binary tree **900** represents the development of an advertisement selection history **356**, **356***a* of the user profile **352**. The binary tree **900** includes a plurality of nodes **392**. Each of the nodes **392** represents a potential advertisement **358** to be presented to the user **20** via the overlay **362**, and connectors of the nodes **392** represent potential selections **366** by the user **20**. As advertisements **358** are iteratively displayed and selected, the binary tree **390** is traversed, the advertisement selection history **356** is developed, and demographics of the associated user **20** may be inferred with increasing certainty. While, in the example shown, a single binary tree **900** is traversed, representing the inference of a single demographic classification within a single demographic category, the implementation of multiple binary trees **900** is possible. The examples of FIGS. **3**B-**3**E illustrate the development of the user profile **352** to infer a gender of the user **20**. Accordingly, the advertisement manager **532** identifies and presents each of the advertisements **358** based on a strong correlation between the advertisement **358** and a particular gender. Particularly, in this example, the advertisement manager **332** is configured to always identify and present one advertisement **358***a* with a strong correlation to male users **20** and another advertisement **358***b* with a strong correlation to female users **20**. In similar implementations, any number of demographic classifications of any number demographic categories may be inferred by the ACR environment **10**. Furthermore, one or more binary trees **900** may be traversed to determine any number of demographic categories. For example, in the first iteration, the advertisement manager **332** may identify and insert advertisements **358** based on a gender inference of the user **20**, and in the second iteration the advertisement manager **332** may identify and insert advertisements **358** based on an age inference of the user **20**. Additionally or alternatively, the ACR environment **10** may traverse multiple binary trees **900** simultaneously to concurrently infer multiple demographic classifications. For example, in the first iteration the advertisement manager **332** may identify and insert a first advertisement **358** having a strong correlation to a first gender and a first age and a second advertisement **358** having a strong correlation to a second gender and a second age. A selection of the first advertisement **358** by the user **20** may lead to the inference that the user **20** can be classified in the first gender and the first age. Successive iterations by the advertisement manager **332** increase a certainty of inferences.

Referring to the example of FIGS. **3**B and **3**C with continued reference to FIG. **3**A, in the first iteration, the advertisement manager **332** initializes the user profile **352**, which does not yet include the advertisement selection history **356**. Accordingly, the advertisement manager **332** identifies a first advertisement **358**, **358***a* and a second advertisement **358**, **358***b* in the replacement media storage **354** based on predetermined advertisement selection instructions. For example, the advertisement manager **332** may identify the first advertisement **358**, **358***a*, which strongly correlates to a first demographic classification of a first demographic category, and the second advertisement **358**, **358***b*, which strongly correlates to a second demographic classification of the first demographic category. As shown in FIG. **3**C, the first advertisement **358**, **358***a* corresponds to Advertisement A for a health and beauty product directed towards males, ages 18-65, and having an income greater than $40,000 per year, while the second advertisement **358**, **358***b* corresponds to Advertisement B for a health and beauty product directed towards females, ages 18-65, and having an income greater than $40,000 per year.

With the first advertisement **358**, **358***a* and the second advertisement **358**, **358***b* identified, the advertisement manager **332** provides the advertisements **358**, **358***a*, **358***b* to the overlay **362**. As shown in FIG. **3**B, the first advertisement **358**, **358***a* and the second advertisement **358**, **358***b* may be provided as a first interactive portion **364**, **364***a* and a second interactive portion **364**, **364***b* of the overlay **362**. The interactive portions **364** may include a preview or summary of the respective advertisement **358** included therein. For example, the interactive portion **364** may include a thumbnail image, video segment, or a description of the respective advertisement **358** included therein, to communicate the context of the respective advertisement **358** to the user **20**.

The inserter **334** communicates the overlay **362**, including the interactive portions **364**, to the television **30**, **30***a* via the replacement media content stream S_R. As introduced above, the inserter **334** may substitute or overlay the portions of the media device stream S_D including the additional media content stream S_C, whereby the overlay **362** is only substituted or overlaid for advertisements **358** included in the media device stream S_D, and does not overlap with the media content of the broadcast media stream S_B. However, the inserter **334** may provide the overlay **362** at a period of time prior to the additional media content stream S_C, whereby the overlay **362** is displayed concurrently with the broadcast media stream S_B portion of the media device stream S_D. Accordingly, the user **20** may select either of the advertisements **358** in advance of the additional media content stream S_C so that the selected advertisement **358** can be substituted for the additional media content stream S_C without delay or overlap. If the overlay **362** is provided concurrently with the broadcast media stream S_B portion of the media device stream S_D, the overlay **362** may be partially transparent so that the broadcast media stream S_B portion of the media device stream S_D is viewable through the overlay **362**. Alternatively, the broadcast media stream S_B portion of the media device stream S_D may be reformatted, whereby the broadcast media stream S_B is displayed on a first portion of the television **30**, **30***a* and the overlay **362** is displayed on a second portion of the television **30**, **30***a*.

Once displayed on the television **30**, **30***a*, the interactive portions **364** may be user-selectable, for example, by a touch-sensitive screen or by buttons on a remote control (not shown). For example, the first interactive portion **364**, **364***a* may identify a first button of the remote control, such as a red button, as corresponding to a selection of the first advertisement **358**, **358***a*, while the second interactive portion **364**, **364***b* identifies a second button of the remote control, such as a blue button, as corresponding to a selection of the second advertisement **358**, **358***b*. Alternatively, the interactive portions **364** may be user-selectable by other methods of feedback, such as voice, touch, or gesture.

In the example of FIG. **3**B, the second interactive portion **364**, **364***b* including the second advertisement **358**, **358***b* is selected by the user **20**, as signified by the hand and the dashed box. The content manager **32** then records the advertisement selection **366**, **366***a* in the advertisement data source **350**, and the selection **366**, **366***a* is included in the advertisement selection history **356** of the user profile **352**, as shown in FIG. **3**A. Referring to the binary tree **390** of FIG. **3**B, the advertisement selection history **356**, **356***a* is illustrated as advancing from a root node **392**, **392***x* to a second leaf node **392**, **392***b* representing Advertisement B. Accordingly, the user profile **352** is partially developed, and indicates with a first certainty that the associated user **20** may be a female.

Referring now to the example of FIGS. **3**D and **3**E, in the second iteration the user profile **352** has already been partially developed and includes the advertisement selection history **356**, **356***a* created in the example of FIG. **3**A. Accordingly, the content manager **32** may associate the user profile **352** with the media device stream S_D so that the advertisement manager **332** can identify and insert advertisements **358** that may be relevant to the associated user **20**.

In the second iteration, the advertisement manager **332** queries the advertisement data source **350** for the advertisement selection history **356**, **356***a* corresponding to the user **20** associated with the media device stream S_D. The advertisement manager may identify and insert a third advertisement **358**, **358***c* and a fourth advertisement **358**, **358***d* based on the advertisement selection history **356**, **356***a* developed during the first iteration. The third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d* may be identified and inserted based on a likelihood of increasing the user profile certainty in view of the selection **366**, **366***a* made during the first iteration. For example, as illustrated by the binary tree **390**, **390***b*, because the user **20** selected the second advertisement **358**, **358***b* corresponding to a female user, the advertisement manager **332** identifies and inserts Advertisement E and Advertisement F as the third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d*, respectively. As shown in FIG. **3**E, the third advertisement **358**, **358***c* corresponds to Advertisement E for a household product directed towards males, ages 32-54, and having an income greater than $40,000 per year, while the fourth advertisement **358**, **358***d* corresponds to Advertisement F for a health and beauty product directed towards females, ages 32-54, and having an income greater than $40,000 per year. However, if the user **20** had selected the first advertisement **358**, **358***a* corresponding to a male user in the first iteration, the advertisement manager **332** may insert Advertisement C and Advertisement D in the second iteration, which may relate to a different product or target demographic. Alternatively, the third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d* may be predetermined for the second iteration, regardless of the selection **366**, **366***a* made during the first iteration. For example, the Advertisement C and Advertisement D may be identified and inserted as the third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d* regardless of whether the user **20** selected Advertisement A or Advertisement B in the first iteration.

With the third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d* identified, the advertisement manager **332** provides the advertisements **358** to the overlay **362**, **362***b*, and the inserter communicates the overlay **362**, **362***b* to the television **30**, **30***a* for display to the user **20**. As shown in FIG. **3**D, the third advertisement **358**, **358***c* and the fourth advertisement **358**, **358***d* may be displayed as a third interactive portion **364**, **364***c* and a fourth interactive portion **364**, **364***d*. As discussed above with respect to the first iteration, once the overlay **362**, **362***b* is displayed on the television, the third interactive portion **364**, **364***c* and the fourth interactive portion **364**, **364***d* may be user-selectable.

In the example of FIGS. **3**C and **3**D, the fourth interactive portion **364**, **364***d* including the fourth advertisement **358**, **358***d* (Advertisement F) is selected by the user **20**, as signified by the hand and the dashed box. The content manager **32** records the advertisement selection **366**, **366***b* in the advertisement data source **350**, and the advertisement selection **366**, **366***b* is included in the advertisement selection history **356** of the user profile **352**, as shown in FIG. **3**A. Referring to the binary tree **390**, **390***b* of FIG. **3**D, in the second iteration the advertisement selection history **356**, **356***b* advances from the second leaf node **392**, **392***b* to a sixth leaf node **392**, **392***f*, representing the selection **366**, **366***b* of Advertisement F. Accordingly, the user profile **352** is further developed, and indicates with a second certainty that the associated user **20** may be a female.

Successive iterations of the method are executed until the user profile certainty satisfies the user profile certainty threshold. For example, the ACR environment **10** may traverse from the sixth leaf node **392**, **392***f* to a ninth leaf node **392**, **392***i*, and further, to an eleventh leaf node **392**, **392***k*, based on selections **366** made by the user **20**.

FIG. **4** illustrates a method **400** for inferring demographics of the user **20**. At block **402**, the method **400** includes receiving the media device stream S_D from the media device **30**. As discussed above, the media device stream S_D may include a media broadcast stream S_B portion and an additional media content S_C portion. At block **404**, the method **400** includes receiving media device fingerprints **222**, **222***b* indicative of media device frames F_D of the media device stream S_D at the corresponding media device **30**. At block **406**, the method **400** includes identifying a portion of media device frames F_D for insertion of an interactive overlay **362** into the media device stream S_D. At block **408**, the method **400** may include receiving an advertisement selection history **356** of the user **20**. Block **408** may be optional, as signified by the dashed line. For example, in a first iteration of the method **400**, the advertisement selection history **356** may not be available. At block **410**, the method **400** includes obtaining a first advertisement **358** and a second advertisement **358**. When block **408** is executed in the method **400**, block **410** may include obtaining the first advertisement **358** and the second advertisement **358** based on the advertisement selection history **356**. However, when block **408** is not executed in the method **400**, such as in a first iteration, the first advertisement **358** and the second advertisement **358** may be predetermined. At block **412**, the method **400** may include receiving an overlay trigger **342** to prompt insertion of the overlay **362** into the media device stream S_D. At block **414**, the method **400** includes inserting the interactive overlay **362** including the first advertisement **358** and the second advertisement **358** into the identified media device frames F_D. At block **416**, the method **400** includes receiving an advertisement selection **366** indicating an impression of the user **20** with respect to the first advertisement **358** and the second advertisement **358**. At block **418**, the method **400** includes storing the advertisement selection **366** of the user **20** in an advertisement data source **350** to initialize or develop the advertisement selection history **356**. At block **420**, the method **400** may include initializing or developing a user profile **352** by inferring a demographic classification of the user **20** based on the advertisement selection **366**. At block **422**, the method **400** may include determining whether a user profile certainty satisfies a user profile

certainty threshold. If the user profile certainty does not satisfy the user profile certainty threshold, the method returns to block **404** to execute another iteration. If the user profile certainty does exceed the user profile certainty threshold, the method **400** may be completed.

FIG. **5** is schematic view of an example computing device **500** that may be used to implement the systems and methods described in this document. The computing device **500** is intended to represent various forms of digital computers, such as laptops, desktops, workstations, personal digital assistants, servers, blade servers, mainframes, and other appropriate computers. The components shown here, their connections and relationships, and their functions, are meant to be exemplary only, and are not meant to limit implementations of the inventions described and/or claimed in this document.

The computing device **500** includes a processor **510**, memory **520**, a storage device **530**, a high-speed interface/controller **540** connecting to the memory **520** and high-speed expansion ports **550**, and a low-speed interface/controller **560** connecting to a low-speed bus **570** and a storage device **530**. Each of the components **510**, **520**, **530**, **540**, **550**, and **560**, are interconnected using various busses, and may be mounted on a common motherboard or in other manners as appropriate. The processor **510** can process instructions for execution within the computing device **500**, including instructions stored in the memory **520** or on the storage device **530** to display graphical information for a graphical user interface (GUI) on an external input/output device, such as display **580** coupled to high-speed interface **540**. In other implementations, multiple processors and/or multiple buses may be used, as appropriate, along with multiple memories and types of memory. Also, multiple computing devices **500** may be connected, with each device providing portions of the necessary operations (e.g., as a server bank, a group of blade servers, or a multi-processor system).

The memory **520** stores information non-transitorily within the computing device **500**. The memory **520** may be a computer-readable medium, a volatile memory unit(s), or non-volatile memory unit(s). The non-transitory memory **520** may be physical devices used to store applications (e.g., sequences of instructions) or data (e.g., application state information) on a temporary or permanent basis for use by the computing device **500**. Examples of non-volatile memory include, but are not limited to, flash memory and read-only memory (ROM)/programmable read-only memory (PROM)/erasable programmable read-only memory (EPROM)/electronically erasable programmable read-only memory (EEPROM) (e.g., typically used for firmware, such as boot applications). Examples of volatile memory include, but are not limited to, random access memory (RAM), dynamic random access memory (DRAM), static random access memory (SRAM), phase change memory (PCM) as well as disks or tapes.

The storage device **530** is capable of providing mass storage for the computing device **500**. In some implementations, the storage device **530** is a computer-readable medium. In various different implementations, the storage device **530** may be a floppy disk device, a hard disk device, an optical disk device, or a tape device, a flash memory or other similar solid state memory device, or an array of devices, including devices in a storage area network or other configurations. In additional implementations, a computer program product is tangibly embodied in an information carrier. The computer program product contains instructions that, when executed, perform one or more methods, such as those described above. The information carrier is a computer- or machine-readable medium, such as the memory **520**, the storage device **530**, or memory on processor **510**.

The high-speed controller **540** manages bandwidth-intensive operations for the computing device **500**, while the low-speed controller **560** manages lower bandwidth-intensive operations. Such allocation of duties is exemplary only. In some implementations, the high-speed controller **540** is coupled to the memory **520**, the display **580** (e.g., through a graphics processor or accelerator), and to the high-speed expansion ports **550**, which may accept various expansion cards (not shown). In some implementations, the low-speed controller **560** is coupled to the storage device **530** and a low-speed expansion port **590**. The low-speed expansion port **590**, which may include various communication ports (e.g., USB, Bluetooth, Ethernet, wireless Ethernet), may be coupled to one or more input/output devices, such as a keyboard, a pointing device, a scanner, or a networking device such as a switch or router, e.g., through a network adapter.

The computing device **500** may be implemented in a number of different forms, as shown in FIG. **5**. For example, it may be implemented as a standard server **500***a* or multiple times in a group of such servers **500***a*, as a laptop computer **500***b*, as part of a rack server system **500***c*, as part of a handheld device **500***d*, or as part of a smart television **500***e*.

Various implementations of the systems and techniques described herein can be realized in digital electronic and/or optical circuitry, integrated circuitry, specially designed ASICs (application specific integrated circuits), computer hardware, firmware, software, and/or combinations thereof. These various implementations can include implementation in one or more computer applications that are executable and/or interpretable on a programmable system including at least one programmable processor, which may be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device, and at least one output device.

These computer applications (also known as computer programs, software, software applications or code) include machine instructions for a programmable processor, and can be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. A software application (i.e., a software resource) may refer to computer software that causes a computing device to perform a task. Example applications include, but are not limited to, system diagnostic applications, system management applications, system maintenance applications, word processing applications, spreadsheet applications, messaging applications, media streaming applications, social networking applications, and gaming applications.

As used herein, the terms "machine-readable medium" and "computer-readable medium" refer to any computer program product, non-transitory computer readable medium, apparatus and/or device (e.g., magnetic discs, optical disks, memory, Programmable Logic Devices (PLDs)) used to provide machine instructions and/or data to a programmable processor, including a machine-readable medium that receives machine instructions as a machine-readable signal. The term "machine-readable signal" refers to any signal used to provide machine instructions and/or data to a programmable processor.

The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to

perform functions by operating on input data and generating output. The processes and logic flows can also be performed by special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit). Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Computer readable media suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

To provide for interaction with a user, one or more aspects of the disclosure can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube), LCD (liquid crystal display) monitor, or touch screen for displaying information to the user and optionally a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input. In addition, a computer can interact with a user by sending documents to and receiving documents from a device that is used by the user; for example, by sending web pages to a web browser on a user's client device in response to requests received from the web browser.

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. Accordingly, other implementations are within the scope of the following claims.

The invention claimed is:

1. A method performed by a computing system, the method comprising:

designating, for replacement, a first video frame of a media device stream that is queued for playback by a media device;

selecting a first demographic classification within a first demographic category and a second demographic classification within a second demographic category based on a first selection of a first advertisement received via a user interface of the media device;

determining that a second advertisement corresponds to the first demographic classification within the first demographic category and that a third advertisement corresponds to the second demographic classification within the second demographic category;

replacing the first video frame with a second video frame that includes the first advertisement and the second advertisement;

receiving, via the user interface, a second selection of either the first advertisement or the second advertisement; and

determining a user characteristic based on the second selection.

2. The method of claim **1**, further comprising storing data representing the user characteristic in a database.

3. The method of claim **1**, further comprising:

designating, for replacement, a third video frame of a media device stream that is queued for playback by the media device;

replacing the third video frame with a fourth video frame that includes a fourth advertisement and a fifth advertisement;

receiving, via the user interface, a third selection of either the fourth advertisement or the fifth advertisement; and

verifying the user characteristic based on the third selection.

4. The method of claim **1**, further comprising receiving a trigger, wherein replacing the first video frame with the second video frame comprises replacing the first video frame with the second video frame in response to receiving the trigger.

5. The method of claim **1**, wherein designating the first video frame comprises determining that the first video frame matches a reference video frame.

6. The method of claim **5**, wherein the first video frame comprises an advertisement.

7. The method of claim **1**, wherein determining the user characteristic comprises comparing a user profile certainty with a user profile certainty threshold.

8. A method comprising:

designating, for replacement, a first video frame of a media device stream that is queued for playback by a media device;

replacing the first video frame with a second video frame that includes a first advertisement and a second advertisement;

receiving, via a user interface, a selection of either the first advertisement or the second advertisement; and

determining a user characteristic based on the selection,

wherein the first advertisement corresponds to a first leaf node of a binary tree and the second advertisement corresponds to a second leaf node of the binary tree, the second leaf node sharing a common parent node with the first leaf node, the binary tree comprising a plurality of leaf nodes, each leaf node of the plurality of leaf nodes having a corresponding advertisement with a corresponding demographic.

9. The method of claim **8**, wherein the common parent node corresponds to an advertisement associated with a previous selection.

10. A computing system comprising:

a processor; and

a computer readable medium storing instructions that, when executed by the processor, cause the computing system to perform functions comprising:

designating, for replacement, a first video frame of a media device stream that is queued for playback by a media device;

selecting a first demographic classification within a first demographic category and a second demographic classification within a second demographic category based on a first selection of a first advertisement received via a user interface of the media device;

determining that a second advertisement corresponds to the first demographic classification within the first

demographic category and that a third advertisement corresponds to the second demographic classification within the second demographic category;

replacing the first video frame with a second video frame that includes the first advertisement and the second advertisement;

receiving, via the user interface, a second selection of either the first advertisement or the second advertisement; and

determining a user characteristic based on the second selection.

11. The computing system of claim **10**, the functions further comprising storing data representing the user characteristic in a database.

12. The computing system of claim **10**, the functions further comprising:

designating, for replacement, a third video frame of a media device stream that is queued for playback by the media device;

replacing the third video frame with a fourth video frame that includes a fourth advertisement and a fifth advertisement;

receiving, via the user interface, a third selection of either the fourth advertisement or the fifth advertisement; and

verifying the user characteristic based on the third selection.

13. The computing system of claim **10**, the functions further comprising receiving a trigger, wherein replacing the first video frame with the second video frame comprises replacing the first video frame with the second video frame in response to receiving the trigger.

14. A computing system comprising:

a processor; and

a computer readable medium storing instructions that, when executed by the processor, cause the computing system to perform functions comprising:

designating, for replacement, a first video frame of a media device stream that is queued for playback by a media device;

replacing the first video frame with a second video frame that includes a first advertisement and a second advertisement;

receiving, via a user interface, a selection of either the first advertisement or the second advertisement; and

determining a user characteristic based on the selection,

wherein the first advertisement corresponds to a first leaf node of a binary tree and the second advertisement corresponds to a second leaf node of the binary tree, the second leaf node sharing a common parent node with the first leaf node, the binary tree comprising a plurality of leaf nodes, each leaf node of the plurality of leaf nodes having a corresponding advertisement with a corresponding demographic.

15. The computing system of claim **14**, wherein the common parent node corresponds to an advertisement associated with a previous selection.

16. A non-transitory computer readable medium storing instructions that, when executed by a computing system, cause the computing system to perform functions comprising:

designating, for replacement, a first video frame of a media device stream that is queued for playback by a media device;

selecting a first demographic classification within a first demographic category and a second demographic classification within a second demographic category based on a first selection of a first advertisement received via a user interface of the media device;

determining that a second advertisement corresponds to the first demographic classification within the first demographic category and that a third advertisement corresponds to the second demographic classification within the second demographic category;

replacing the first video frame with a second video frame that includes the first advertisement and the second advertisement;

receiving, via the user interface, a second selection of either the first advertisement or the second advertisement; and

determining a user characteristic based on the second selection.

17. The non-transitory computer readable medium of claim **16**, further comprising storing data representing the user characteristic in a database.

18. The non-transitory computer readable medium of claim **16**, further comprising:

designating, for replacement, a third video frame of a media device stream that is queued for playback by the media device;

replacing the third video frame with a fourth video frame that includes a fourth advertisement and a fifth advertisement;

receiving, via the user interface, a third selection of either the fourth advertisement or the fifth advertisement; and

verifying the user characteristic based on the third selection.

19. The non-transitory computer readable medium of claim **16**, further comprising receiving a trigger, wherein replacing the first video frame with the second video frame comprises replacing the first video frame with the second video frame in response to receiving the trigger.

20. The non-transitory computer readable medium of claim **16**, wherein designating the first video frame comprises determining that the first video frame matches a reference video frame.

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